

WHAT IS CALLED IS:

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1. A method for processing an in-process substrate using a plasma, comprising the steps of:

generating a plasma in a processing chamber in which the in-process substrate is disposed; and

processing the in-process substrate with a plasma generated in the processing chamber, wherein the plasma processing step of the in-process substrate further comprises:

an irradiation step of projecting a light beam into the processing chamber through an observation window;

a detection step of detecting reflected light from the inside wall of the processing chamber at the irradiation step, through the observation window; and

a signal processing step of obtaining information on the state of contamination of the inside wall of the processing chamber, by processing a signal obtained through detection of the reflected light at the detection step.

2. A method for processing an in-process substrate using a plasma according to Claim 1, further comprising

a control step of controlling the plasma processing for the in-process substrate, based on the information on

the state of contamination of the inside wall obtained at the signal processing step.

3. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the detection step, a speckle pattern of the reflected light from the inside wall of the processing chamber is imaged by an imaging optical system, and received at a detector before detection.

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4. A method for processing an in-process substrate using a plasma according to Claim 3, wherein at the detection step, when the reflected light is imaged by an imaging optical system through the observation window and received by a detector, a light generated from the plasma in the processing chamber is cut off by a filter.

5. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the irradiation step, when the beam is projected into the inside of the processing chamber, the light generated is scanned so as to be projected onto a plurality of locations on the inside wall of the processing chamber.

6. A method for processing an in-process substrate using a plasma according to Claim 1, wherein projecting the light

beam into the inside of the processing chamber at the irradiation step and detecting the reflected light image at the detection step are conducted through the same observation window.

7. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the detection step, the reflected light from the inside wall of the processing chamber varies in accordance with a variation in the state of irregularity of the inside wall of the processing chamber.

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8. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the irradiation step, a light beam intensity-modulated by a desired frequency is projected into the inside of the processing chamber through the observation window.

9. A method for processing an in-process substrate using a plasma according to Claim 8, wherein at the signal processing step, information on the state of contamination of the inside wall of the processing chamber is obtained by extracting the intensity modulated frequency component from the received light signal detected at the detection step.

10. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the detection step, a light image limited by a diaphragm placed at an imaging position of the imaging optical system is received by a detector.

11. A method for processing an in-process substrate using a plasma according to Claim 1, wherein at the irradiation step, the light beam to be projected into the inside of the processing chamber has a desired wavelength, and at the detection step, the desired wavelength component is separated from the reflected light image before detection.

12. A method for processing an in-process substrate using a plasma, comprising the steps of:

generating a plasma in a processing chamber in which an in-process substrate is disposed;

processing the in-process substrate with a plasma generated in the processing chamber;

wherein the plasma processing step of the in-process substrate further comprises:

projecting a light beam into the inside of the processing chamber through an observation window;

branching reflected light from the inside of the processing chamber resulting from the irradiation and passed through the observation window;

obtaining information on suspended foreign materials in the processing chamber by detecting one of the branched portions of the reflected light; and

obtaining information on the state of contamination of the inside wall of the processing chamber by detecting the other of the branched portions of the reflected light

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13. A method for processing an in-process substrate using a plasma according to Claim 12, further comprising a step of controlling the plasma processing for the in-process substrate, based on information on the suspended foreign material in the processing chamber and information on the state of contamination of the inside wall of the processing chamber.

14. A method for processing an in-process substrate using a plasma according to Claim 12, wherein at the step of projecting the light beam, a light beam intensity-modulated by a desired frequency is projected into the inside of the processing chamber.

15. A method for processing an in-process substrate using a plasma according to Claim 14, wherein at the step of obtaining the information on the suspended foreign materials, information on the suspended foreign material in the processing chamber is obtained by extracting a component of a desired intensity-modulated frequency from the signal obtained by detecting one of the branched portion of the reflected light.

A 16. A method for processing an in-process substrate using a plasma according to Claim 14, wherein at the step of obtaining the information on the state of contamination of the inside wall of the processing chamber, information on the state of contamination of the inside wall of the processing chamber is obtained by extracting a component of a desired intensity-modulated frequency from the signal obtained by detecting the other branched portion of the reflected light.

17. A method for processing an in-process substrate using a plasma according to Claim 12, wherein both of the light beam to be projected into the inside of the processing chamber at the irradiation step and the reflected light from the inside of the processing chamber at the step of branching

the reflected light pass through the same observation window.

18. A method for processing an in-process substrate using a plasma according to Claim 12, wherein at the step of obtaining the information on the state of contamination of the inside wall of the processing chamber by detecting the other branched portion of the reflected light, the scattered reflected light component from the inside wall of the processing chamber, among the other branched portion of the reflected light, is cut off by a spatial filter before detection.

19. An apparatus for processing an in-process substrate by generating a plasma, comprising:

a processing chamber with an observation window, in which the in-process substrate is disposed;

plasma generating means for generating a plasma in the inside of the processing chamber;

irradiation means for projecting a light beam into the inside of the processing chamber through the observation window;

detection means for detecting the light that has been projected by the irradiation means and reflected by the inside wall of the processing chamber, and

processing means for obtaining the information on the state of contamination of the inside wall of the processing chamber by processing a signal obtained through detection of the reflected light by the detection means.

A 20. A plasma processing apparatus according to Claim 19, further comprising control means for controlling the plasma processing of the in-process substrate, based on information on the state of contamination of the inside wall of the processing chamber that has been obtained by the processing means.

21. A plasma processing apparatus according to Claim 19, wherein the irradiation means projects the light beam into the inside of the processing chamber in a scanning manner.

22. A plasma processing apparatus according to Claim 19, wherein the irradiation means projects a light beam intensity-modulated with a desired frequency into the inside of the processing chamber.

23. A plasma processing apparatus according to Claim 22, wherein the processing means obtains the information on the state of contamination of the inside wall of the processing chamber by extracting the intensity modulated frequency.

component from signals obtained through detection of the reflected light by the detection means.

24. A plasma processing apparatus according to Claim 19, wherein the detection means is equipped with an imaging optical system and detects an optical image of the reflected light from the inside wall of the processing chamber.

25. A plasma processing apparatus according to Claim 24, wherein the detection means detects a speckle pattern image.

26. A plasma processing apparatus according to Claim 24, the detection means detects an light image that is restricted by a diaphragm being set at an imaging position of the imaging optical system.

27. A plasma processing apparatus according to Claim 19, wherein the detection means detects the reflected light through the observation window, through which the irradiation means made the light beam pass.

28. A plasma processing apparatus according to Claim 19, wherein the irradiation means and the detection means share a wave plate, by which the irradiation means changes a polarization state of the light beam to be projected into

the inside of the processing chamber by the irradiation means and also by which the detection means changes a polarization state of the reflected light from the inside of the processing chamber.

29. An apparatus for processing an in-process substrate by generating a plasma, comprising:

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a processing chamber with an observation window, in which an in-process substrate is disposed;

plasma generating means for generating a plasma in the inside of the processing chamber;

irradiation means for projecting a light beam into the inside of the processing chamber through the observation means;

branching means for branching the reflected light that has been projected by the irradiation means, reflected from the inside of the processing chamber, and passed through the observation window;

foreign-material detecting means for obtaining information on suspended foreign materials in the processing chamber by detecting one of portions into which the reflected light has been branched by the branching means; and

state-of-contamination detecting means for obtaining information on the state of contamination of the inside wall

of the processing chamber by detecting the other of portions into which the reflected light has been branched by the branching means.

A 30. A plasma processing apparatus according to Claim 29, further comprising, control means for controlling plasma processing for the in-process substrate, based on both of information on the suspended foreign materials in the processing chamber that has been detected by the foreign-material detecting means and information on the state of contamination of the inside wall of the processing chamber that has been detected by the state-of-contamination detecting means.

31. A plasma processing apparatus according to Claim 29, wherein the irradiation means projects light beam intensity-modulated by a desired frequency into the inside of the processing chamber.

32. A plasma processing apparatus according to Claim 31, wherein the foreign-material detecting means obtains information on the suspended foreign materials in the processing chamber by extracting a component of a desired intensity-modulated frequency from signals obtained by

detecting one of portions into which the reflected light has been branched by the branching means.

33. A plasma processing apparatus according to Claim 31, wherein the state-of-contamination detecting means obtains information on the state of contamination of the inside wall of the processing chamber by extracting a component of a desired intensity-modulated frequency from signals obtained by detecting the other of portions into which the reflected light has been branched by the branching means.

A 34. A plasma processing apparatus according to Claim 29, wherein at irradiation means, both the light beam projected into the inside of the processing chamber and the reflected light from the inside of the processing chamber that has been branched by the branching means, are pass through the same observation window of the processing chamber.

35. A plasma processing apparatus according to Claim 29, wherein the state-of-contamination detecting means is equipped with a spatial filter that cuts off a scattered reflected light component from the inside wall of the processing chamber, among the other of portions into which the reflected light has been branched by the branching means.